
WHAT'S WORKING

Changing a Course from Lecture Format to Cooperative Learning

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For almost thirty years I have taught a senior course in marine geology. Although I have revised it over the years, it has always been a lecture course. Fall Quarter 1994, I substantially changed my approach: I gave only three lectures and three demonstrations the entire quarter. Students learned primarily through cooperative assignments and individual projects.

This method is called "cooperative learning." The 22 students in the class worked in teams of four or five, discussing their reading and sharing information. There were no examinations; grades were based on five written reports turned in by each student.

Although the course was very successful, I undertook the change with only two weeks preparation. It should surprise no one, therefore, that some improvements were in order before I taught the course again.

A Change for Students

For the students, change began on the first day. They learned that they would be expected to discuss the assigned reading and to teach it to other students. Furthermore, they would be writing one-page and two-page summaries of readings often, and five-page reports every couple of weeks. The emphasis would be on their

ability to express themselves in terms of the science they were studying.

Another major change was the importance of class attendance. (The class met hourly four days a week.) Because the students were part of a team, their absence would let their team down and make learning difficult for other students. Attendance in the course was far better than in the years when I lectured. Some students even emailed or telephoned me that they would be absent on a particular day—an action unheard of in my lecture course.

The Basic Course Structure

The basic course structure was one that I learned about at a conference on undergraduate geoscience education. Each team of four or five students was given an assigned reading on the topic under discussion. Although the readings were usually different for each team, the contents overlapped.

For example, on the topic of cliff erosion at the shoreline, Team 1 read an excerpt on the mechanical processes of wave erosion of cliffs, Team 2 on slumping due to surface water percolation, and Teams 3, 4, and 5 on cliff erosion along the coasts of Oregon, California, and the United Kingdom, respectively.

Each member of each team wrote a one-page summary of the main points in the reading, which was handed in at the beginning of the discussion. I marked that copy and returned it during the next class period. I did not assign a grade but provided feedback on whether the main points were detected, stated accurately, etc. A second copy of the paper was used by the students in class for discussion. Each team was to discuss the reading until each person in the team understood it.

The team discussions usually took an entire hour. I was there to answer questions, provide clarification, and

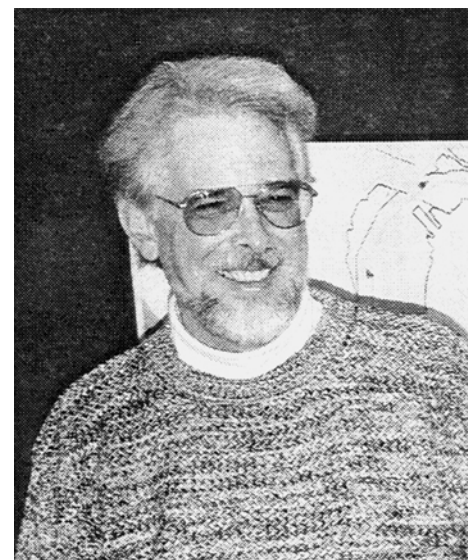
assist when needed. That the class met in a lab, with desk top lab benches (uninterrupted by sinks or shelves) facilitated discussion because the students could sit across from one another. But team discussions were also successful in the auditorium, where we met on days when I wanted the class to see slides.

When the teams were confident of their understanding, they broke into mixed groups. Each group consisted of at least one member of each

team. A team member's responsibility was to teach the others what his or her team had learned from the reading. This discussion likewise took at least one hour or more. During the discussion I walked around the room, listening to the discussions several times, answering questions, helping detect relationships among the readings.

For the next class period each student was expected to hand in a two-page paper summarizing the main points for all the readings. I marked these papers and returned them the next

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class period, again for feedback. No grade was assigned.

Variations on the Basic Structure

To provide relief from repetition of the basic structure and the writing assignments, I included some variations.

Viewing slides. After several readings on water waves, we spent a class period viewing color slides of different types of waves. The purpose was for students to apply written descriptions or explanations of waves to the visual objects. For example, slides taken of beaches provided the opportunity to talk about beach slopes, grain size, wave energy, and littoral drift direction.

Exercises. Exercises allowed students to apply the information learned from reading. For one exercise, each team was given a navigation chart, graph of data, or a problem to solve, all related to the same topic. They spent the class period answering questions regarding the topic and preparing a presentation. Then two members of each team stayed at their station with their chart or problem while the other team members walked around the room visiting other stations and hearing their presentations. Later the students switched, so that those who had been presenting and answering questions could visit the other teams.

Posters. On a few topics, all teams were assigned the same reading. Each team was asked to select the most important information, prepare a poster on the topic, and constructively review the other posters. The first year I included this assignment, the class voted for the best poster, which was placed in a display case outside the auditorium. The next year, students in Ocean 101 reviewed the posters and provided feedback on how successful they were in communicating the information.

Lectures. I gave three one-hour lectures during the course. I added them for clarification when the students

evinced confusion or uncertainty in the team discussion. (Lecturing beforehand would have been a better arrangement for the very difficult topics.)

Grading

Grades in the course were based on five projects. The students could work on them cooperatively, but each student had to submit his or her own report, all but one of which was limited to five pages. (They learned that writing a short paper is more difficult than writing a long one.)

An example is a project that was assigned after the students had read and discussed waves, beaches, and cliffed coastlines. The students were told that they had been asked for some advice by a couple who owns property on the shore of Puget Sound. After the couple had read newspaper articles (such as one attached to the assignment) about natural hazards along the shoreline, they became worried about their property. They had an assessment, but they wanted the students to look at the property and, using various sources of information, decide whether the assessment was accurate.

The students were free to locate the couple's "property" anywhere on the shoreline of Puget Sound. Some students selected the same site; all visited their sites. Several included photos of their sites in their reports. Many interviewed homeowners or workers near their sites.

In this project the students had to observe significant features relating to erosion, slope stability, deposition,



Professor McManus answers questions posed by one of the groups during a class session. The same students work together throughout the quarter.

sediment transport, or flooding. They had to compare their observations with published information, and draw inferences and justify them. It all had to be written in plain English since the homeowners had only a layperson's knowledge of science.

Challenges for the Teacher

In changing from a lecture format to the cooperative learning structure described above, I encountered several difficulties.

Changing goals. The major difficulty was having to change my goal in teaching. In lecturing I always thought in terms of "the students ought to know *this* about marine geology," or more accurately: "They ought to know *about this*." This was some bit of information, some fact, some kind of research, some discovery, some equation, some concept.

Now I had to think in terms of "the students ought to be able to *do this*." They ought to be able to observe keenly, compute accurately, reason cogently, describe results clearly, hypothesize, and to test hypotheses rigorously. They ought to be developing "a scientific habit of mind."

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The difference in these two goals was made real when I realized that I could cover only half the topics that I had covered in lectures. The discrepancy shocked me. I later learned that this is about the average reduction. Nevertheless, I felt I had shortchanged the students. Because only about half the topics covered in lectures can be covered by this method, considerable care must go into selecting those topics.

Leaving the lectern. The instructor must give up apparent control of the classroom. Although I selected the topics and the reading, I am not the fount of knowledge in front of the class. I am a facilitator, walking around the room, assisting when required. I am not safely behind my notes at the lectern. I am out on the floor, being asked questions from out of the blue.

Coordinating reading assignment. Selecting the reading assignments is difficult. If the readings for the teams do not overlap sufficiently, then the study in the mixed groups reverts to the old lecture mode with amateur lecturers. But finding overlapping readings at the right level of comprehension is a challenge.

Student attendance is essential. A difficulty arises if, for any reason, a few students are not able to attend class regularly. Their teams are suddenly understaffed, and it may be necessary to move students from other teams to balance the numbers for the mixed groups. However, this tends to destroy the team spirit for the students so moved.

Benefits of Cooperative Learning

The greatest pleasure of this approach is being among the students and getting to know them, with their individual personalities, clever and astute at times, naive at other times. I've been at the UW more than 30 years and it is embarrassing and sad for me to realize how many hundreds of students have

come through my classroom without direct contact with me.

To walk about a room and hear students talking to one another about the science I love thrills me. They are spending the entire hour talking to one another about science, about concepts, about methods, teaching one another, learning from one another. Most of them find it easy to enter into conversation with me, chatting with me before or after class about other courses, plans after graduation, and various things that faculty and students do not spend enough time discussing.

Another enjoyment was seeing these students show evidence of becoming scientists. That a student makes a good grade on an examination tells me little about how good a scientist he or she might be. But to read reports in which students give evidence of sharp observation, orderly thinking, and clear expression, is rewarding. I also feel more useful to them in developing these skills than I do in grading their examinations.

Assessment of Method

The basic question after such a teaching change is: Are the students learning? Four of the students who were in the class present their evaluation in an accompanying article. Here I offer an example of the difference between these students and students in the course when I lectured.

One project on shoreline assessment has been assigned in this class for years. On the day that students hand in their reports, I ask them to share their conclusions with the class. In the past, few students would speak. One, remaining seated, might recount an anecdote in approximately half a

minute. A second or third student might mention something. And that was that.

By contrast, in the class taught through cooperative learning, several students responded immediately to my request. The first one went to the blackboard, drew the profile of the cliffed shoreline she had studied, and summarized her evidence and conclusion. The students applauded her. The next student went to the board, did the same, was applauded, and around the room we went. Every student spoke freely about the results of the project. They were obviously more capable and confident of speaking about their research than were the students who had sat in lecture class.

Cooperative learning can be exciting and rewarding for both instructor and students. It takes preparation and work by everyone. Everyone is challenged and, by the end of term, exhausted. Fewer topics are covered than in lecture but the goal is different. It is not for the instructor to narrate more information, but for the students to learn better how to think as scientists. Flexibility on the part of the instructor is essential. If you tell the students what you are trying to do, it will work out. I have never enjoyed teaching a course so much, nor received such high student evaluations, nor had students "earn" (their word) such high grades in my thirty years of teaching.

If you have questions about using cooperative learning, you can contact the Center for Instructional Development and Research at (206) 543-6588, or at info@cidr.washington.edu.

Student Perspectives of a Cooperative Learning Experience

By Elizabeth Housel, Adrienne Huston, Colin Martin, and Tammara Pierce

We took Professor McManus's class, Oceanography 450, during Autumn quarter 1994. We actively participated in each class session; we discussed and taught our own reading and listened to other students as they presented their reading. It was exciting to take on the role of the professor and teach each other science.

Cooperative learning changed many of our study habits. We spent each night preparing for the next day's class; the class met four days a week. For each topic, we read an article, wrote an analytical summary of the main points, discussed it the next day in class, taught the main ideas to our classmates, wrote another summary that related our reading to those of the other students, then finalized our understanding of the material by completing an individual project. This continuous, repetitious exposure to each topic greatly enhanced the learning curve.

The projects gave us the opportunity to apply ourselves and to truly demonstrate what we learned. Rather than a professor providing us with a beach profile or with the sediment characteristics of a beach, we went to the beach, made our own assessment of the profile and sediment characteristics, and provided reasons for what we saw. The projects simulated research and provoked critical thinking skills.

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The cooperative learning format also allowed us to enhance our oral and written communication skills, improve our computer skills, and develop many important research skills.

After graduation, we will be expected to produce results and reports; our ability to communicate those results, to scientists and non-scientists alike, will determine our success in future endeavors. We developed our writing skills by summarizing scientific articles and completing several written projects. We improved our oral communication skills through daily discussion of readings. At the end of the quarter, we each presented our shoreline assessment projects before the entire class. We feel that this style of learning makes students more confident in communicating scientific ideas to an audience.

Dr. McManus provided us an opportunity to develop and expand our computer skills. We learned to utilize spreadsheets for our data in order to produce results with efficiency. We used the Internet to access wave height data and weather information for some of our various projects, opening up a whole new world of data availability.

We also developed the ability to read scientific papers. This is especially important for students going on to graduate school. We not only had to read the articles, but we had to understand them in order to explain the material to our classmates.

Professors can continue to try to teach science through lectures and exams, but until students have to apply the concepts, they will never really learn science. Cooperative learning gave us the opportunity to apply scientific concepts to real problems. We all have pages and pages of notes from our lecture classes, but we have the Marine Geology experience. We can throw our notes away and those other classes will be forgotten, but the skills and experience we gained in Marine Geology will stay with us throughout our careers.